COMBUSTION

Project Fact Sheet

NOx Emission Reduction by Oscillating Combustion

Benefits

- Simple retrofit that does not require modification of burner or furnace
- Increase in heat transfer by up to 13%
- Increase in efficiency or productivity by 5% or more
- Reduction in NOx emissions by up to 75%

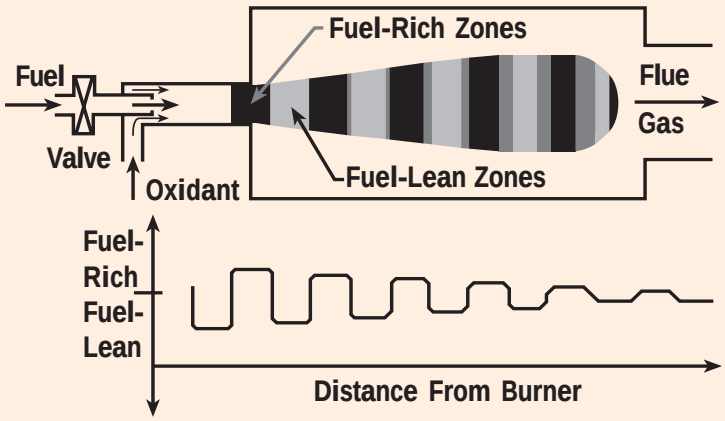
Applications

Oscillating combustion can be applied to many types of furnaces used in steel including box annealing, steel reheating, and ladle drying/preheating. Oscillating combustion can also be used in other high temperature process industries. This patented technology works with ambient air-, preheated air-, oxygen enriched-air-, or oxy-fuel-fired burners. Installation is simple, requiring only the installation of an oscillating valve on the gas line to each burner, a valve controller for each zone, and adjustment of the gas supply pressure to the valves.

Oscillating combustion increases efficiency and reduces NOx emissions of industrial furnaces

High-temperature, natural gas-fired furnaces used in steel and other industries produce large quantities of NOx per unit of material processed. Regulations on emissions from industrial furnaces are becoming increasingly stringent. In addition, competition is forcing operators to make their furnaces more efficient and productive. Oscillating combustion offers the high temperature material processing industries increased efficiency, productivity, and reduced NOx emissions from industrial furnaces whether they are fired with ambient air, preheated air, enriched air, or industrial oxygen. Oscillating combustion is easily retrofitted to existing burners since no modifications to the burner or the furnace are necessary.

Oscillating Combustion



Oscillating combustion creates fuel-rich and fuel-lean zones which increase heat transfer and reduce NOx emissions.

Project Description

Goal: To demonstrate oscillating combustion on a wide variety of industrial burners in the laboratory and on fully retrofitted air- and oxy-fuel-fired furnaces.

Oscillating combustion, in its simplest form, is the oscillation of the fuel flow rate to a burner. A valve is used to oscillate the fuel flow. Oscillation creates successive, NOx-formation-retarding, fuel-rich and fuel-lean zones within the flame. Heat transfer from the flame to the load is increased due to more luminous fuel-rich zones and the breakup of the thermal boundary layer. The increased heat transfer shortens heat-up times, thereby increasing thermal efficiency.

Oscillating combustion is being evaluated on a number of widely used industrial burner types in the laboratory. Field evaluations will follow on small- and large-scale air-fuel-fired industrial furnaces and on an oxy-fuel-fired glass melter. The targets of the field evaluations include a 5% increase in efficiency or productivity, a 50% reduction in NOx emissions, and no adverse impacts on the process.

The Institute of Gas Technology (IGT) is focusing efforts on air-fuel-fired applications, while Air Liquide is focusing on oxy-fuel-fired applications, for which it has an exclusive license from IGT. Two additional companies are developing valves that will reliably produce the gas flow oscillations. CeramPhysics has adapted its solid state proportioning (SSP) valve for use with oscillating combustion. This valve uses an elastometer wafer which is squeezed to close and released to open an annular orifice to produce the gas flow oscillations. GT Development Corporation has developed a Cyclic Valve with a rotating disk that produces the gas flow oscillations.

Progress and Milestones

- Oscillating combustion has been evaluated in the laboratory on at least 8 types of burners, including nozzle mixed, baffle, high velocity, and flat frame. For conventional (not “low-NOx” burners), heat transfer increases of up to 13% and NOx reductions of 55% to 75% have been recorded.
- The CeramPhysics SSP valve has been shown to operate for more than 100 million cycles without degradation in performance. The GT Development Cyclic Valve has been shown to be easily scaleable to large-scale applications such as burners used in steel reheat furances.
- Two field demonstrations of oscillating combustion have been completed. One was on an oxy-fuel-fired rotary iron melter in a foundry. A melt time reduction of 12% to 20% and an efficiency increase of 16% were documented. The other, on a ladle preheater in a steel minimill, showed an efficiency increase of 5%, as well as a substantial reduction in NOx emissions.
- Two more field demonstrations are underway. One is on a batch annealing furnace in a steel mill. The other is on an oxy-fuel-fired melter in a glass plant.
- Using a 5% projected market penetration into the industrial sector, and an estimated 5% fuel savings per installation, total U.S. energy savings would amount to 18 trillion Btu/year.
- Using a 50% NOx reduction per installation, the total reduction in NOx emissions would be 8,000 tons/year. The fuel savings would correspond to a CO_2 reduction of 1 million tons/year.

Cross-Industry Applications

In addition to steel industry applications, oscillating combustion is expected to be used in glass melters, aluminum melting furnaces, metal melting and holding furnaces, ceramic and brick kilns, boilers, and other high temperature furnaces.

Project Partners

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Air Liquide
Countryside, IL

Bethlehem Steel Corporation
Burns Harbor Division
Chesterton, IN

CeramPhysics, Inc.
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